Tree farming guidelines

sappi

4th Edition (2022)

Part 4 - Innovations in forestry

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PART 4 - INNOVATIONS IN FORESTRY

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At the Focus on Forestry conference held in White River, South Africa, in mid-April 2019, SA Forestry summarised the underlying message as follows: “use technology to work smart, improve productivity, health and safety, and take the donkey work out of those repetitive, mindless tasks. But most important of all, do not lose touch with your customers along the way.”[1]

An array of innovative technology is being unleashed upon the forestry landscape, such as the use of telematics in planting machines, to cell phone apps that capture key data logged in the field such as seedling deliveries and procurement, harvest yields and sales, orders, and GIS maps.

There is a strong requirement for monitoring forests and crops to tackle the present challenges within agriculture and forestry. Near real-time monitoring is crucial to react to extreme events - such as climate conditions or pest infestations - and thus minimise their impact, while also optimising management practices - such as precision agriculture - in a sustainable manner.[2]

Remote sensing is the process of detecting the physical characteristics of an area by measuring reflected light from satellites, aircrafts or drones using specialised cameras. These cameras can pick up light waves not visible to the human eye, allowing research to uncover patterns and “sense” characteristics about the earth.

Remote sensing is commonly used in agriculture and can identify, monitor, and assess the condition of crops without physically visiting them. When this data is organised in a computer mapping system, it becomes a valuable tool in making decisions about crops and agricultural strategies.

1. Drones

Advancements in the technology of batteries, motors and digital cameras have led to the development of small, cheap unmanned aerial vehicles, or drones. The possibilities that these new tools bring to an industry like forestry are endless, and they offer the opportunity to do everyday tasks faster, cheaper, cleaner, and safer. Some of the basic applications already developed are:

- Mapping – providing high resolution imagery of smaller areas quickly and cheaply.
- Spraying – low level aerial application of herbicide and fungicide before planting and spraying over established crops.
- Crop health monitoring – multispectral sensors can provide quick NDVI (Normal Differential Vegetation Index) and NDWI (Normal Differential Water Index) analysis of standing timber crops.
- Tree counting and height measurement – advanced software can identify individual tree crowns and determine their height above the ground surface.
- Terrain modelling – by the same process as determining tree heights, accurate ground surface models can be compiled from drone imagery.

- Stockpile measurement – composite images of timber stacks on depot can be used to calculate the volume of stock available.
- Fire detection – thermal cameras carried by larger drones have been able to detect fires and hotspots not otherwise visible.
- Security – drones have made it easier to patrol forest areas by getting a bird's eye view through the canopy and covering a much larger area that ground patrols.
- Damage detection – visual, thermal, and multispectral images of a forest canopy can be used to detect several types of damage, from drought stress to insect attack.

Small consumer drones, weighing less than 7kg, may be operated by anyone provided they abide by the following rules:

- It should be flown within visual line of sight of the operator, always.
- It may not be operated higher than 120 m above ground level.
- It may not be operated within 10 km of any airport, aerodrome, or airfield.
- It may not come within 30 m of any person, vessel or structure that is not under the operator's control.
- It may not be used over urban areas such as villages, towns, and cities.
- It may not be operated within any controlled, restricted or prohibited airspace.
- You may not operate a drone without the permission of the landowner, or in the case of a forestry plantation, the landowner representative.

Photo 1: Crop spraying

Photo 2: Mapping

Photo 3: Stem count

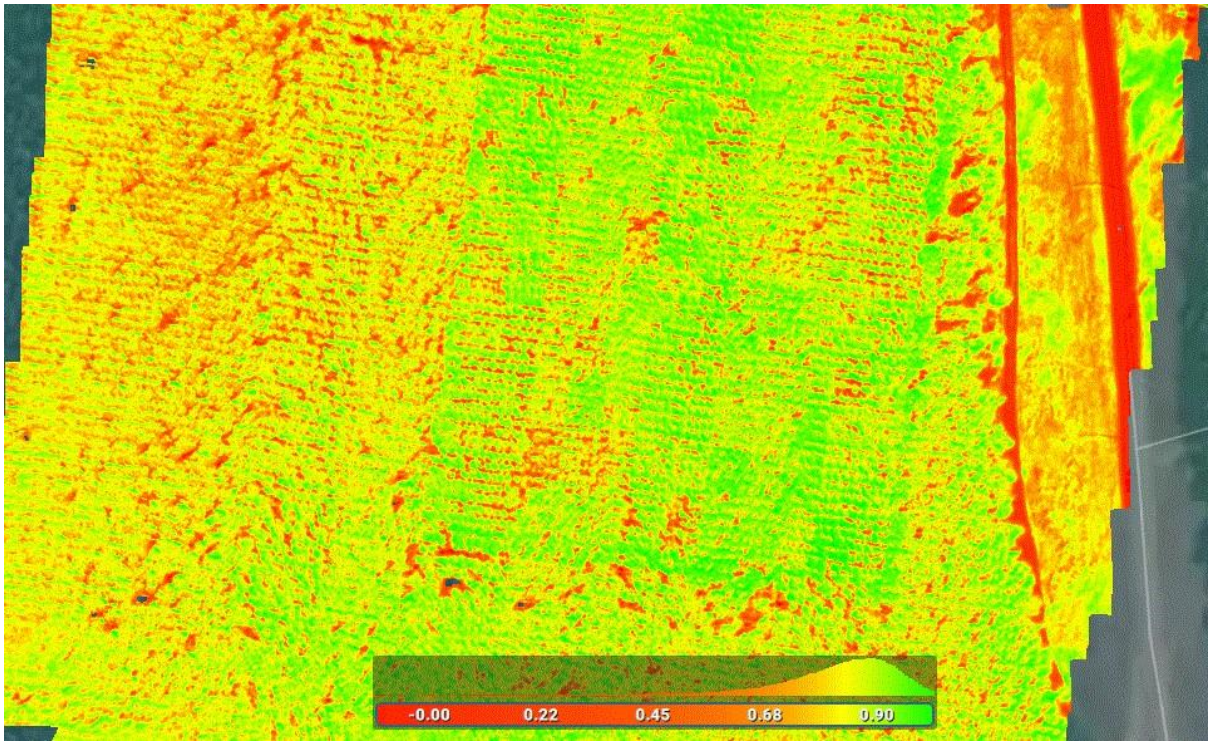


Photo 4: Multispectral NDVI

Photo 5: Thermal drone

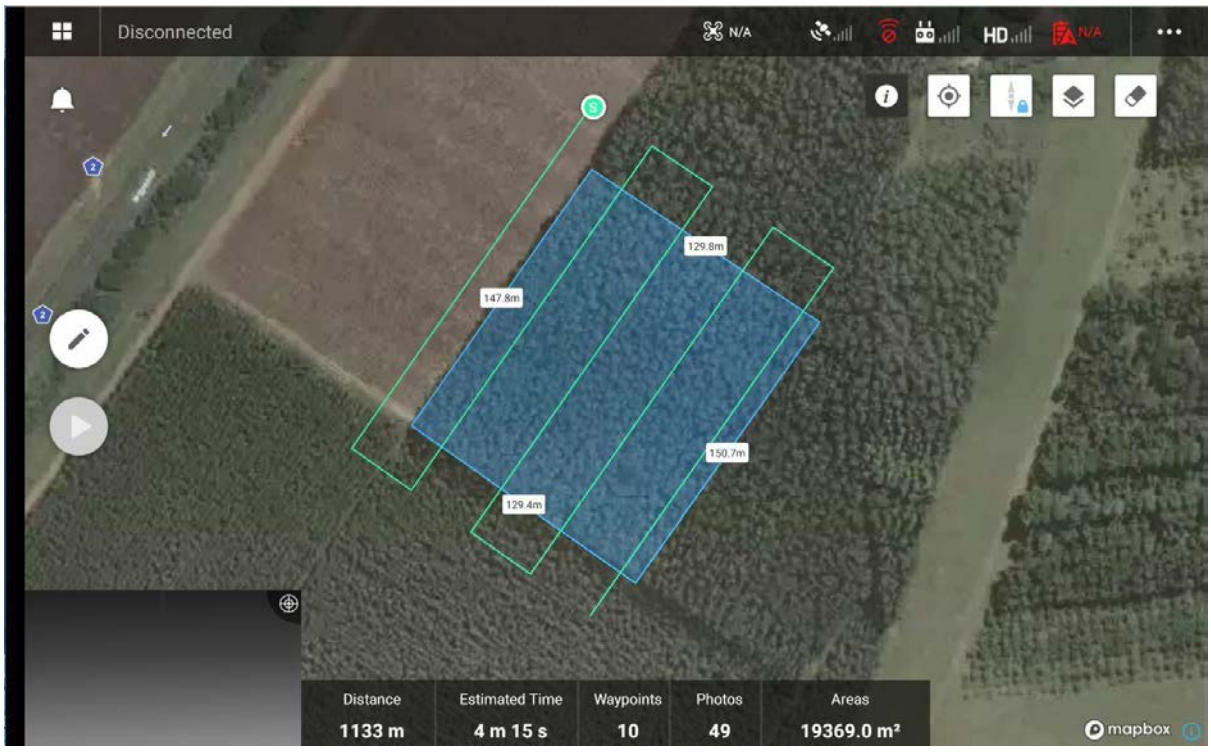


Photo 6: Flight plan

2. Satellites

Satellite remote sensing has also been used extensively in forested environments. Some of the common applications include:

- Tree health monitoring. Vegetation indices combine various bands/images to see things that the human eye cannot. Vegetation indices are good indicators of vegetation cover, health, and growth dynamics.

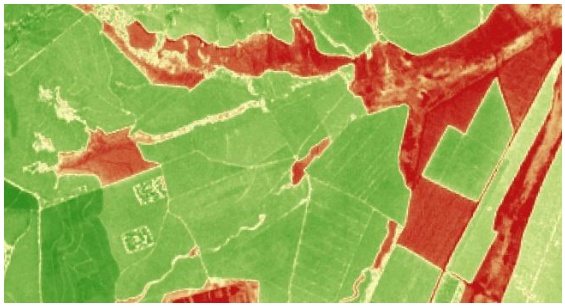


Photo 7a (left): An image showing the visible bands (bands the human eye can see).

Photo 7b (right): Index highlighting vegetation health.

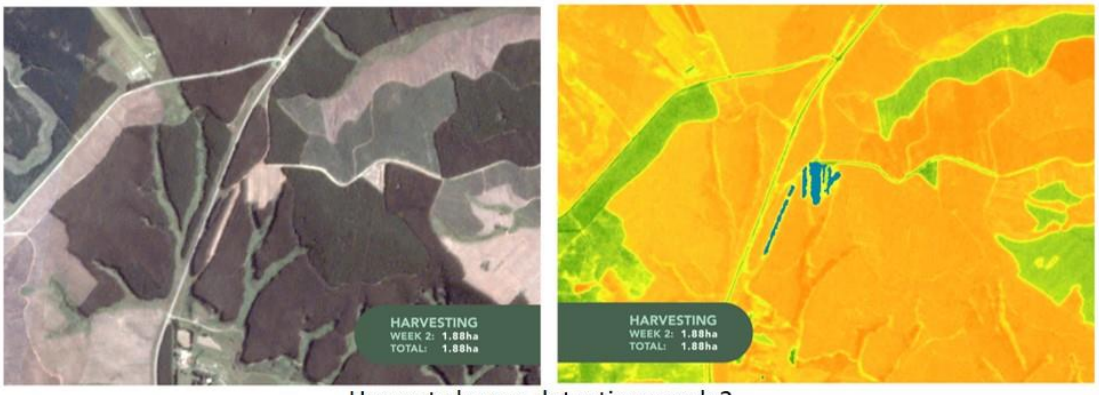
- Assessment of snow damage. Certain satellite bands can highlight damage to vegetation caused by snow. They highlight areas where snow is detected and the subsequent reduction in vegetation health.

- Frost risk mapping. Remote sensing allows analysts to monitor land surface temperatures. Using specific algorithms combined with this data, it is possible to classify areas that could be susceptible to frost damage.

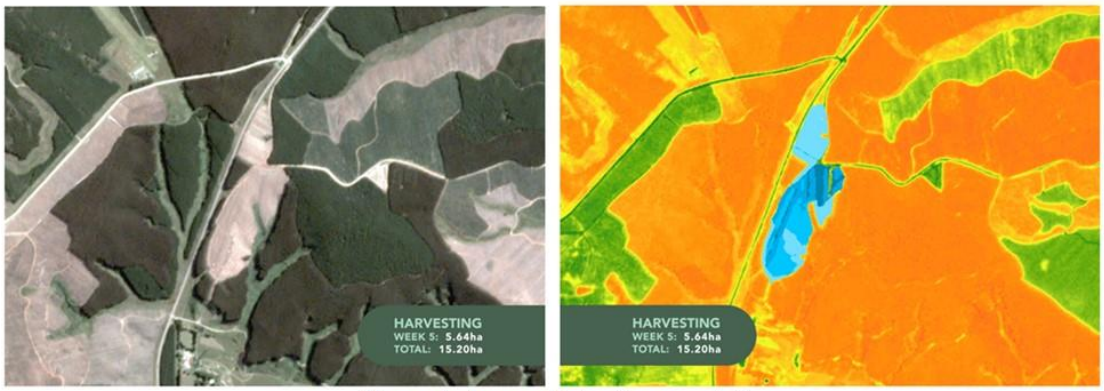
Photo 8: A map showing high frost risk areas in red

- Harvest detection. Certain satellites have an extremely fast revisit time (they take images of the same area at frequent intervals). This allows for weekly monitoring of harvesting operations. A significant decline in vegetation health is a good indicator of harvesting operations and this is an effective way to monitor harvesting progress. It

can also indicate theft if an area that was not planned for harvesting gets picked up as being cleared.



Harvest change detection week 2



Harvest change detection week 5

Photo 9: Harvest detection and montioring using high resolution satellite imagery.

- Drought monitoring**.** During a drought event, the vegetation canopy can become severely stressed. This has a major impact on plant development and can cause crop failure or lower crop production. Remote sensing can show plant health and indicate plant water content, aiding in the identification of drought-affected areas.

- Land use mapping. Accurate mapping of land use is crucial for determining precise plantable areas. Using the latest high-resolution imagery, analysts can update the boundaries of compartments on a regular basis without having to go in field to GPS.

Photo 10: A map showing land use mapped from remote sensing imagery.

3. References

1. SA Forestry https://saforestryonline.co.za/.
2. Boag, S (2020) Seeing through the Trees: Monitoring Agriculture and Forestry with Satellite Imagery. https://www.gim-international.com/case-study/monitoring-agriculture-and-forestry-using-satellite-imagery.
3. Aggarwal, S. (2004). Principles of remote sensing. Satellite remote sensing and GIS applications in agricultural meteorology, 23, 23-28.
4. Holmgren, P., & Thuresson, T. (1998). Satellite remote sensing for forestry planning—a review. Scandinavian Journal of Forest Research, 13(1-4), 90-110.
5. Hajimirzajan, A., Vahdat, M., Sadegheih, A., Shadkam, E., & El Bilali, H. (2021). An integrated strategic framework for large-scale crop planning: sustainable climate-smart crop planning and agri-food supply chain management. Sustainable Production and Consumption, 26, 709-732.

I thought you foresters were ordinary people whose deeds did not rise above the killing of game. But you are great, free from the tyranny of egoism, and the fruits of your quiet activities ripen in the distant future. Hero and poet achieve vain glory! Truly, if I were not a poet, I would want to be a forester! Friedrich von Schiller (1759-1805)